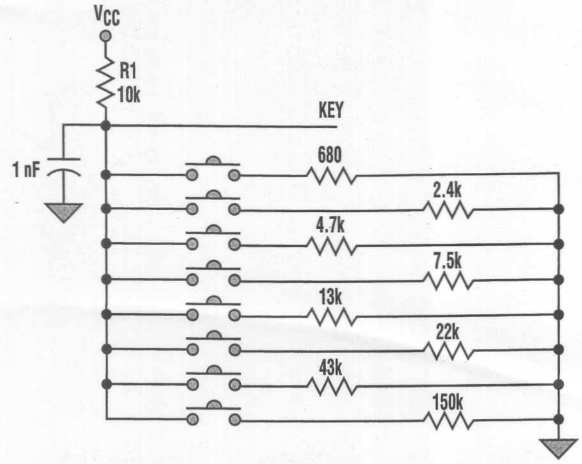

To determine which key is pressed, a resistive divider network functions as a crude digital-to-analog converter that produces an output signal (KEY). Then, an MCU's analog input reads the KEY signal.

at low conversion speeds.

Next, note that the divider network must slice the MCU's ADC digital range into equal-sized bins. If B is the bin size, N represents the number of bits in the ADC, and K the number of keys scanned:

$$B = 2^N/K$$

For a 10-bit converter scanning eight keys, B = 1024/8 = 128 counts per bin. The edges of the bins are simply multiples of this number.

To compute the target "key-pressed" value in the middle of each bin for each key, k (starting at k = 0), we have:

$$X_k = kB + B/2$$

For the 10-bit example, the threshold for the first bin is 64, for the second bin 64 + 128 = 192, and so on.

The value of the resistor attached to each switch is then:

$$R = (X_k R1)/(2^N - X_k)$$

So the first bin's resistor is 667 Ω, the second is 2308 Ω, etc. The closest 5% values are shown in the figure.

The resistor tolerance must be chosen according to the number of keys and bins. With eight keys, the bins are 1/8 = 12.5% wide. By carefully selecting the values, ±5% resistors may be used while keeping each key's voltage within its bin. For 16 or more keys, the bin size is 6.25%, and you will need 1% resistors to ensure that each key's voltage stays within its bin.

This technique really suits low-power systems because the keypad draws zero power until a key is pressed. If the MCU's analog input can be configured for wake-on-pin-change, then the MCU can go to sleep until a key is pressed. ***ED Online 3560***

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Extend Voltage Range Of Current-Shunt Monitor

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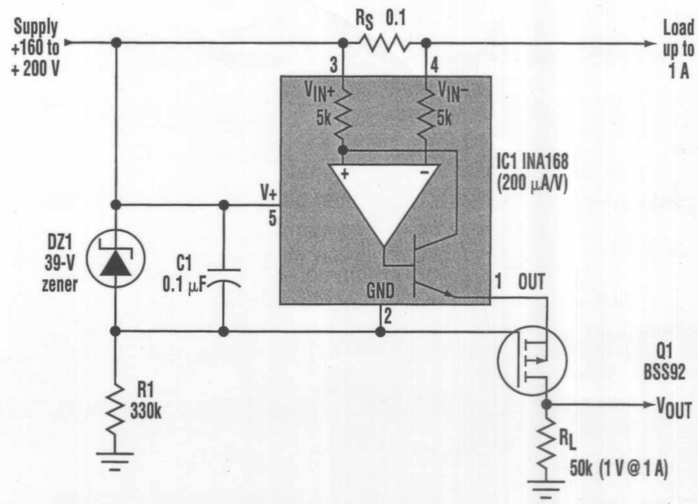
While current-shunt-monitor ICs like the INA168 can be connected to current-shunt resistors at supply voltages of up to 60 V, the circuit shown in the figure allows current sensing at even higher voltages. This method can be extended to any voltage for which a suitable MOSFET for Q1 can be found.

Zener diode DZ1 regulates the current-shunt monitor's supply voltage. This voltage "floats" relative to the supply voltage. DZ1 is chosen to provide sufficient operating voltage for the combination of IC1 and Q1 over the expected power-supply range (typically 5.1 to 56 V).

First, select R1 to set DZ1's bias current at some value greater than IC1's maximum quiescent current. The INA168 shown is specified at 45 µA maximum. The bias current in DZ1 is approximately 500 µA at 200 V, much greater than IC1's maximum current. (The bias-current value was selected to limit dissipation in R1 to less than 0.1 W.)

Connect a p-channel MOSFET (Q1) as shown to cascode the output current of IC1 down to, or below, ground level. Q1's voltage rating should exceed the difference between the total supply voltage and DZ1 by several volts, because of the upward voltage swing on Q1's source. Select R2, IC1's load resistor, as if IC1 were used alone. This circuit was specifically designed to operate from 160 to 200 V and sense up to 1 A of current at a 1-V full-scale output. ***ED Online 3561***



A cascode connection of Q1 enables using IC1 well in excess of its normal 60-V rating. In this example, it can be used up to 200 V.

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